GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL MANAGEMENT
(COURSE CODE 3350501)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma chemical engineer has to manage the production as a responsible chemical technician and first line supervisor in the industries. They have to apply principles and techniques of management to utilize the human resources and manage the processes and operations in best possible way. They have to optimize the resource utilisation and apply the managerial aspects in cost reduction and different problem solving activities. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency

- **Apply managerial skills to enhance efficiency of production.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Manage human resources using system and organization concepts
ii. Manage Inventory applying concepts of material management
iii. Control and monitor production by applying management techniques
iv. Plan and implement projects applying management techniques
v. Perform and use value analysis for cost reduction

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**100**
3	0	0	3	70	30	00	00	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit I Concept of System and Management	1a. Explain concepts of system 1a.1 State Types of systems	1.1 Definition of system
		1.2 Types of systems
		1.3 System parameters
		1.4 System variable
		1.5 System behavior
	1b. Discuss management and Explain its functions	1.6 Fundamentals of management
		1.7 Functions of management
Unit II Organization Structure and Organizational Dynamics	2a. Describe management structure 2b. Explain various factors for structure 2c. Describe various management processes	2.1 Definition, Goals, Factors considered in formulating structure
		2.2 Division of labor, Scalar and functional processes, Span of control, Delegation of authority, Centralization and Decentralization
	2d. Classify the organization 2e. Apply SWOT analysis of organizational structure 2f. Explain factors affecting Organizational culture	2.3 Types, advantages, disadvantages, flexibility and applications of organization structure
		2.4 Organizational culture and factors affecting organization culture
	2g. Discuss moral and relate it with productivity 2h. Identify factors affecting job satisfaction	2.5 Moral: factors affecting moral
		2.6 Relationship between moral and productivity
		2.7 Effect of high and low moral
		2.8 Job satisfaction, factors influencing job satisfaction
Unit III Material Management	3a. Discuss importance of material management	3.1 Definitions, Functions, Importance of material management, Relationship with other departments
	3b. Explain purchase procedure and system	3.2 Objectives of purchase, Purchase systems, Purchase procedure, Terms and various forms used in purchase department
	3c. Classify stores 3c.1 List out various functions of storekeeping 3d. Compare methods of storekeeping	3.3 Functions of storekeeping classification of stores as centralized and decentralized with their advantages, disadvantages and application
	3e. Describe functions of storekeeper 3f. List Types of records types of storage equipment	3.4 Functions of store keeper, Types of records maintained by store, various types of storage equipment, Codification of stores
	3g. Discuss Objectives of inventory control and derive expression for EOQ 3h. Distinguish inventory analysis and inventory models	3.5 Definition of inventory control, objectives of inventory control, Derivation of expression for EOQ, ABC analysis, other modern methods of analysis 3.6 Inventory models such as Willson's model, Replenishment model, Two bin model
Unit IV Management Techniques	4a. Explain objectives and applications of PPC and CPM , PERT	4.1 Meaning, features, objectives of (1) PPC(Production, planning and control) (2) CPM(Critical path method) (3) PERT(Programme Evaluation and Review Technique)
	4b List out functions of PPC	4.2 Functions of PPC with necessary

		forms used in it
	4c Calculate critical ratio using Gantt charts	4.3 Types of productions, Calculation of Economic Batch Quantity (EBQ), Critical ratio scheduling and Gantt charts
	4d. Draw network diagram and determine its critical path	4.4 Different terms used in network diagram by CPM/PERT
	4e. Determine floats and explain crashing of network	4.5 Draw network diagram for a real life project containing 10-15 activities, Computation of LPO, EPO 4.6 Determination of critical path on network
		4.7 Floats, its types and determination of floats 4.8 Crashing of network and its application
	4f. Describe concept of value analysis with its importance and various method	4.9 Concept of value analysis, important methods used in value analysis, VA flow diagram
Unit V Factory Act and Laws	5a. Describe various provisions of Factory act and its important provisions	5.1 Factory act and its important provisions
		5.2 Workman Compensation Act its important provisions
		5.3 Industrial Dispute Act and its important provisions

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Concept of System and Management	4	02	05	00	7
II	Organization Structure and Organizational Dynamics	08	05	06	03	14
III	Material Management	13	07	07	07	21
IV	Management Techniques	13	06	07	08	21
V	Factory Act and Laws	04	03	02	02	7
Total		**42**	**23**	**27**	**20**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i.Course/topic based presentation ii.Group discussion

8. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Give real life or fabricated case studies related to different managerial problems faced in chemical industries and ask students to identify reasons for problem and suggest probable solutions. Have Group Discussions on these solutions.

ii. Show motivational videos related to human resource management.

iii. Use role play method to teach proper methods of dealing patiently with difficult subordinates/colleagues/ Seniors.

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Factory Management & business organization	A.S Despande	Vora & Co. Publishers Pvt. Ltd., Mumbai, 1962
2	Business organization & management	M.C.Shukla	S. Chand & Co., New Delhi, 1970
3	Industrial Engineering & Management	O. P. Khanna	Dhanpat Rai Publications, New Delhi, 1980
4	CPM & PERT principles and Applications	L.S.Srinath	3rd Edition Affiliated East-West Press Private Limited, New Delhi, 1971

B. List of Software/Learning Websites

i. www.idc.iitb.ac.in/~chakku/dm/06_Pert%20cpm.ppt
ii. www.clib.dauniv.ac.in/E-Lecture/PERT-CPM.pdf
iii. www.pitt.edu/~super7/30011-31001/30961.ppt
iv. www.newagepublishers.com/samplechapter/001386.pdf
v. www.unesco.org/education/aladin/paldin/pdf/course02/unit_14.pdf
vi. www.du.ac.in/fileadmin/DU/Academics/course_material/EP_08.pdf

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J. R .Vadher,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar
- **Prof. S. K. Charola,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar,
- **Prof. P. H. Shukla,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar
- **Prof. N. N. Hansalia,** Lecturer in Chemical Engineering G. P. Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

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COURSE TITLE: MASS TRANSFER-II
(COURSE CODE: 3350502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

3. RATIONALE

Diploma Chemical engineer have to supervise the preliminary purification of raw materials or final separation of products from by-products. They have to deal with changes in composition of solutions known as the mass-transfer operations. The large numbers of towers used for petroleum refining are examples of mass transfer operations. A substantial number of the unit operations of chemical engineering are concerned with the problem of changing the compositions of solutions and mixtures through methods involving chemical reactions. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

4. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Perform separation operations for purification of raw materials and products**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Operate equipments for gas-liquid operations.
ii. Perform distillation operations.
iii. Calculate the product rate and number of trays for binary distillation.
iv. Calculate various terms associated with humidity.
v. Operate drying systems.
vi. Use the concept of adsorption and ion exchange.
vii. Operate various crystallisers.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**200**
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

2 COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Equipment for Gas Liquid Operations	1a. Describe importance of Gas-Liquid operations	1.1 Importance of Gas-Liquid operations
	1b. Classify equipments for Gas-Liquid operations	1.2 Classification of equipments for Gas-Liquid operations
	1c. Describe construction of equipments with diagram of 1.3 & 1.4 1d. Explain working principle and operation of equipments with sketches of 1.3 & 1.4	1.3 Gas dispersed 1.3.1 Sparged vessel 1.3.2 Mechanically Agitated Vessel 1.3.3 Tray tower 1.3.3.1 Types of trays 1.3.3.2 Operating problems in tray tower 1.3.3.3 Tray efficiency 1.4 Liquid dispersed 1.4.1 Venturi scrubber 1.4.2 Wetted wall column 1.4.3 Spray tower 1.4.4 Packed tower and its operating problems
	1d. Distinguish different types of packing with diagram	1.5 Types of packing (a) Random (b) Regular
Unit – II Distillation	2a Describe applications	2.1 Distillation as a versatile separation method
	2b Describe the steps to Plot VLE, Constant pressure, Constant temperature equilibria	2.2 Vapor Liquid Equilibria 2.2.1Constant pressure equilibria 2.2.2 Constant temperature equilibria
	2c Explain Relative volatility and laws - Raoult's, Henry's 2c.1 State their uses	2.3 Relative volatility 2.4 Raoult's law, Henry's law, and their uses
	2d Differenetiate azeotropes	2.5 Maximum and minimum boiling azeotropes
	2e Explain -Flash vaporisation, Differential distillation, Continuous rectification 2f Calculate amount and composition for Flash vaporization 2g Calculate product composition for Differential distillation	2.6 Flash vaporization 2.6.1 Material balance 2.6.2 Calculation of amount and composition 2.7 Differential distillation 2.7.1 Derivation of Rayleigh's equation 2.7.2 Calculation of product composition 2.8 Continuous rectification of binary solution 2.8.1 The fractionation operation 2.8.2 Overall material and enthalpy balances
	2f. Apply McCabe-Theile method for multistage tray tower for enriching and stripping section 2f.1 Calculate product rates, minimum reflux ratio and number of trays for the given data	2.9 McCabe and Thiele method for enriching and stripping section 2.9.1 Introduction of Feed and Location of the feed tray 2.9.2 Total reflux ratio, Minimum reflux ratio, Optimum reflux ratio 2.9.3 Calculations of product rates, minimum reflux ratio and number of trays
	2g. Compare distillation techniques viz (a) Steam distillation (b)Vacuum and molecular distillation (c)Azeotropic and extractive distillation	2.10 Important distillation techniques (a) Steam distillation (b)Vacuum and molecular distillation (c)Azeotropic and extractive distillation
	2h. Distinguish Reboilers	2.11 Reboilers and their use

Unit – III Humidification	3a. Analyse the VLE for a pure substance	***Humidification:*** 3.1 Vapor-pressure curve 3.2 Saturated and unsaturated vapor-gas mixtures
	3b. Explain the concepts of Absolute humidity, Relative saturation, Percentage saturation, Dew point, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature, Humid volume, Humid heat, Enthalpy	3.3 Concept of Absolute humidity, Relative saturation, Percentage saturation, Dew point, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature, Humid volume, Humid heat, Enthalpy
	3c.Evaluate the property of air using DBT and WBT 3e.1 Calculate –absolute humidity, relative saturation, percentage saturation for the given process data	3.4 Calculations of absolute humidity, relative saturation, percentage saturation
	3d. Draw psychometric chart 3d.1 List Purposes of contact of gas with pure Liquid	3.5 Psychometric charts for Air-Water system 3.6 Purposes of contact of gas with pure Liquid
	3e. Explain construction and working with diagram	3.7 Equipments 3.7.1 Cooling towers 3.7.2 Spray chambers 3.7.3 Spray ponds
Unit – IV Drying	4a. Discuss drying equilibrium and related concepts 4a.1 Define and calculation of Moisture content, Equilibrium and free moisture, Bound and unbound moisture 4a.2 Calculate - Moisture content, Equilibrium and free moisture, Bound and unbound moisture from the given data	4.1 Drying equilibrium 4.1.1 Insoluble solids 4.1.2 Hysterisis 4.1.3 Soluble solids 4.1.4 Definitions and calculation of Moisture content, Equilibrium and free moisture, Bound and unbound moisture
	4b. Classify drying & drying equipments	4.2 Batch and continuous drying 4.3 Classification of drying equipment
	4c. Describe construction and working of Drier equipments	4.4 Construction and working of following Drier equipment • Tray drier • Tunnel drier • Vacuum drier • Rotary drier • Spray drier • Fluidized bed drier • Pneumatic drier
	4d. Describe drying rate characteristics for batch drying with sketches 4d.1 Derive equation for drying time for constant rate period and falling rate period	4.5 Drying rate curve for batch drying 4.6 Derivation of equation for drying time for constant rate period and falling rate period
	4e. Calculate drying time	4.7 Calculation of drying time

Unit – V Adsorption & Ion-Exchange	5a. Define and state uses of Adsorption	***Adsorption & Ion-Exchange:*** 5.1 Definition and industrial application of Adsorption
	5b. Classify Adsorption and adsorbents 5b.1State Commonly used adsorbents	5.2 Types of adsorption 5.3 Nature of adsorbents 5.4 Commonly used adsorbents
	5d. Analyse Adsorption Equilibria 5d.1 Describe Effect of temperature on adsorption and Heat of adsorption	5.5 Adsorption Equilibria 5.5.1 Single gases and vapours 5.5.2 Adsorption hysteresis 5.2.3 Effect of temperature on adsorption and Heat of adsorption
	5e. Apply Freudlich's equation for single stage and multi stage cross-current operation 5e.1Describe adsorption from dilute and concentrated solution	5.6 Adsorption from liquids 5.6.1 Adsorption from dilute solution 5.6.2 The Freundlich's equation 5.6.3 Adsorption from concentrated solutions 5.6.4 Material balance and Freundlich's equation for single stage and multistage cross-current operation
	5f. Describe construction and working of Higgins contactor, Pressure swing adsorber	5.7 Higgins contactor 5.8 Pressure swing adsorber
	5g. Appreciate concepts of Ion Exchange 5g.1 List Applicationv of Ion Exchange	5.9 Ion-Exchange 5.9.1 Principles 5.9.2 Application 5.9.3 Equilibria 5.9.4 Rate of ion exchange
Unit –VI Crystallisation	6a. State Industrial applications of crystallization	***Crystallisation:*** 6.1 Industrial applications of crystallization
	6b. Explain equilibria mechanism for crystallisation 6b.1 State the methods to get Super saturation	6.2 Equilibria and yields 6.3 Super saturation and methods to get it 6.4 Nucleation 6.5 Crystal growth
	6c. Explain working principle and operation of Crystallization Equipment with sketch 6c.1Describe construction of Crystallization Equipment	6.6 Crystallization Equipment 6.6.1 Vacuum crystallizer 6.6.2 Swenson walker crystallizer 6.6.3 Draft tube-baffle crystallizer
	6d. State and explain Meir's theory	6.7 Meir's theory
	6e. Calculate the crystal yield	6.8 Crystallization with and without seeding 6.9 Calculations of crystal yield
	6f. List steps to Prevent caking of crystals	6.10 Caking of crystals and it's prevention

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Equipment for Gas Liquid Operations	6	2	3	2	7
II	Distillation	15	5	7	7	19
III	Humidification	8	2	4	4	10
IV	Drying	10	4	4	5	13
V	Adsorption & Ion-Exchange	10	4	4	4	12
VI	Crystallization	7	3	3	3	9
Total		**56**	**20**	**25**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Demonstrate principle, construction and working of equipments for gas–liquid operations with models	4
2	I	Prepare vapour liquid equilibria curve at atmospheric pressure for Benzene-Xylene	4
3	II	Carry out simple distillation in glass assembly	4
4	II	Find out the effect of vacuum on distillation of liquid	4
5	II	Carry out continuous rectification in packed column	4
6	II	Find out amount of steam required in steam distillation	4
7	III	Find out the property of atmospheric air with the help of wet bulb and dry bulb temperature	4
8	III	Set desired conditions of humid air in humidity control cabin	4
9	IV	Prepare drying curve of moist sand and moist limestone	4
10	IV	Find out equilibrium moisture content and drying time of wet solid	
11	V	Characterize industrial adsorbents and observe their samples	4

S. No.	Unit No.	Practical/Exercise (Outcomes in psychomotor domain)	Apprx. Hrs. Required
12	V	Remove colour impurities from water using charcoal	4
13	VI	Find out the yield of crystals from saturated solution without seeding	4
14	VI	Find out the yield of crystals of from saturated solution with seeding	4
Total			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit nearby industries and observe the working of mass transfer equipments.
ii. Visit the website of reputed mass transfer equipment manufacturers and prepare a report on these equipments.
iii. Prepare chart/ Model of mass transfer equipments.
iv. Quiz, Debate

9. SPECIAL INSTRUCTIONAL STRATERGY (If Any)

i. Animated videos and drawings of equipments

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1	Mass Transfer Operations	Robert E. Treybal	Mc Graw- Hill, 3rd Edition, 1981
2	Unit Operation of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7th Edition
3	Unit Operations-II	K. A. Gavhane	Nirali Prakashan, Pune
4	Unit Operations of Chemical Engineering, Volume-I	P. Chattopadhyay	Khanna Publishers, New Delhi, 1995
5	Chemical Engineering, Volume-2	Coulsion and Richardson	Butterworth-Heinemann; 5^{th} Edition, 2002
7	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York, 7^{th} Edition, 2004

B. List of Major Equipment/Materials

i. Distillation Assembly : 2000 ml round bottom flask, 1000 ml collection flask, joints, adapter with ¾ neck, simple/coiled glass condenser, thermometer pocket
ii. Packed column : Heating mantle - single phase 240 v AC, 15 amp, max 250 ^{0}C, 2litre Flask, Column- MS and Borosil glass, ID-58 mm, OD-62 mm, Packing-100 mm glass, 400 mm MS, 50 mm glass,12 mm dia rasching ring, Condenser- shell MS, tube Copper, Rotameter-0.5-5 LPH
iii. Steam distillation setup : Distillation kettle - MOC-MS, dia-150 mm, height 300mm; jacket dia 175 mm height, height 300 mm, pressure gauge, steam relief valve, steam feed line with valve, drain valve, steam trap on jacket outlet, 25 mm glass wool insulation with MS cladding; Condenser – MS shell, tube copper dia-150 mm,

height 250; Steam generator inner SS 304, outer MS dia 180 mm, height 270 mm; 25,5litre collecting beaker

iv. VLE apparatus : Heating mantle with 1 litre flask, dimmerstat, digital temp indicator, air and water cooled condenser, mounted on wooden and MS frame, thermocouples

v. Humidity cabin : Double walled thick gauge chamber SS 304, heater 500 W; Cooling circuit with compressor, expansion valve, condenser and refrigerant; Steam generator SS 304; Control panel with digital temperature indicator, low water level indicator, solenoid valve

vi. Tray dryer : Temp range 50-100/200, thick MS chamber, digital temp indicator and controller, Air circulation by induction motor, Tray about 80×40×3 cm

vii. Batch crystallizer : Jacket 325 mm round, 155 mm deep, 3mm thick, annulus 22.5 mm; 25 mm thick glass wool insulation, Aluminium cladding; motor-stirrer 10mm rod, speed regulator

viii. Benzene, Toluene, Xylene, Sand, Limestone, silica gel, Charcoal, boric acid, Sodium sulphate, Potassium permanganate

C List of Software/Learning Websites

i. www.unitoperation.com
ii. http://nptel.ac.in/courses/index.php?subjectId=103103035
iii. http://1rv07ch.files.wordpress.com/2010/05/lecture1-introduction2mass-transfer.pdf
iv. http://www.msubbu.in/ln/mt/
v. http://chemeng.ir/download/Mass-Transfer/Mass_Transfer_Operations_-_Robert_Treybal_chemeng.ir.pdf
vi. http://serve.me.nus.edu.sg/arun/file/teaching/ME6203_2013_Mujumdar.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh B. Shukla**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Upasana T. Singh**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Parul K Patel**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic,
- Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

COURSE TITLE: PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY (COURSE CODE: 3350503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th semester

4. RATIONALE

The development of refining and petro-chemical industries in the country has made it compulsory for

the chemical engineers to get acquainted with important aspects of petroleum refining and petrochemical technology. Every diploma chemical engineer has to invariably handle the vast consumption of petroleum products, their diversity and increasing applications. Diploma holders have to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a smooth and safe manner. These may also helpful in marketing and quality check of petro products. Hence, this course has been designed to develop such competency and skills.

5. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Operate petroleum refinery and petro-chemical plant**

4. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

viii. Characterize crude petroleum and petroleum refinery
ix. Fractionate crude petroleum into useful fractions
x. Measure important physical properties of petroleum products
xi. Apply refinery processes to maximize desired petro products
xii. Use treatment techniques to purify petro products
xiii. Manufacture widely used petrochemicals

5. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

3 COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Petroleum and Refinery	1a. Describe the reserves of Crude Petroleum oil in India 1a.1State basics occurrence of Petroleum 1a.2 Classify Petroleum 1a.3Describe history of Petroleum	1.1 Occurrence and history of Petroleum 1.2 Crude Petroleum oil reserves in India 1.3 Composition of Petroleum 1.4 Classification of Petroleum
	1b. Explain basics of refineries and– products 1b.1State types of Refineries 1b.2Describe Refinery processes- Physical and Chemical changes	1.5 Refineries development in Gujarat and India 1.6 Types of Refineries 1.7 Refinery processes 1.7.1 Physical changes 1.7.2 Chemical changes 1.8 Refinery products
Unit – II Fractionation of Petroleum	2a. Describe primary treatment of crude	Primary treatment of crude : 2.1 Dehydration and Desalting of crude oil 2.2 Pipe still heater
	2b. Describe distillation of crude and crude residue	2.3 Atmospheric distillation of crude 2.4 Vacuum distillation of crude residue
	2c. Identify Physical properties of petroleum products fractions and measure- (Units of measure)	2.5 Physical properties of petroleum products and its measurements : 2.5.1 Petrol 2.5.2 Diesel 2.5.3 Kerosene 2.5.4 Lubricant oil 2.5.5 CNG and LPG 2.5.6 Grease
Unit – III Refinery Processes	3a. Compare Cracking methods 3a.1 Describe the Purpose of cracking & Effect of temperature and pressure on Cracking	3.1 Cracking 3.1.1 Purpose of cracking 3.1.2 Effect of temperature and pressure on Cracking Cracking methods 3.1.3 Thermal cracking 3.1.4 catalytic cracking 3.1.5Fluidised bed catalytic cracking
	3b.Explain need of Reforming 3b.1 Differentiate thermal and catalytic reforming 3b.2 Identify effect of important parameters on reforming 3b.3 Explain Pt catalyst-Reforming	3.2 Reforming 3.2.1 Purpose of Reforming 3.2.2 Differentiate thermal and catalytic reforming 3.2.3 Platforming(Pt catalyst-Reforming)
	3c. Explain in brief refinery processes -Hydrotreating, Hydrocracking, Delayed coking , Visbreaking	3.3 Other important refinery processes 3.3.1 Hydrotreating 3.3.2 Hydrocracking 3.3.3 Delayed coking 3.3.4 Visbreaking
Unit – IV Treatment Techniques	4a. State the purposes of sulphur removal 4a.1 Explain methods of sulphur removal - Doctor's sweetening, Catalytic desulfurization ,	4.1 Purposes and methods of sulphur removal 4.2 Doctor's sweetening 4.3 Catalytic desulfurization 4.4 MEROX treatment

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	MEROX treatment	
	4b. Explain Treatment of Kerosene by liquid SO_2 extraction	4.5 Treatment of Kerosene by liquid SO_2 extraction
	4c. Distinguish solvent extraction processes – Furtural, Phenol, Duo sol	4.6 Solvent extraction processes 4.6.1 Furtural extraction method 4.6.2 Phenol extraction method 4.6.3 Duo sol extraction process
	4d. Describe Purpose of dewaxing 4e. Compare dewaxing Techniques	4.7 Purpose of dewaxing Dewaxing Techniques 4.8 Dewaxing without solvent 4.9 Dewaxing with solvent 4.9.1 Ketone dewaxing and propane dewaxing
Unit – V Petrochemicals	5a. Describe in brief development of petrochemical industry in Gujarat and in India	5.1 Development of petrochemical industry in Gujarat and in India
	5b. Draw flow chart for manufacturing of - C1 compounds- Methanol and Formaldehyde -C2 compounds - Ethylene dichloride ,Vinyl chloride and Ethylene Oxide - C3 compounds- Polypropylene.Propylene oxide -Chemicals from aromatics- Linear Alkyl Benzene Phenol by benzene sulfonate process	5.2 Manufacturing of important C1 compounds 5.2.1 Methanol 5.2.2 Formaldehyde
		5.3 Manufacturing of important C2 compounds 5.3.1 Ethylene dichloride 5.3.2 Vinyl chloride 5.3.3 Ethylene Oxide
		5.4 Manufacturing of important C3 compounds 5.4.1 Polypropylene. 5.4.2 Propylene oxide
		5.5 Chemicals from aromatics 5.6 Manufacture of Linear Alkyl Benzene 5.7 Manufacture of Phenol by benzene sulfonate process

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Petroleum and Refinery	6	4	2	2	8
II	Fractionation of Petroleum	8	4	4	2	10
III	Refinery Processes	10	5	5	3	13
IV	Treatment Techniques	14	6	6	5	17
V	Petrochemicals	18	8	7	7	22
Total		**56**	**27**	**24**	**19**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Prepare a detail chart of modern refinery	2
2	I	Prepare a detail chart of petrochemical products	2
3	II	Determine flash point by Penskey Martin method	2
4	II	Determine fire point by Penskey Martin method	2
5	II	Measure softening point and drop point of Grease	2
6	II	Measure Aniline point of lubricating oil	2
7	II	Determine penetration number of Grease	2
8	II	Determine Carbon residue by Ram's bottom method	2
9	II	Determine Carbon residue by conradson method	2
10	II	Measure smoke point of kerosene	2
11	II	Measure cloud point lubricating oil	2
12	II	Measure pour point lubricating oil	2
13	II	Measure initial & final boiling point of any petroleum product	2
14	II	Measure Viscosity of lube oil by Redwood /Saybolt/Engler viscometer	2
		Total	**28**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. Market survey of various petrochemical products of different manufacturers and their comparison based on their specification, composition and cost
iii. MCQ/Quiz

11. SPECIAL INSTRCTIONAL STRATEGY (IF ANY)

(A) Lecture and demonstration of Animated videos of refinery and petrochemical plant
(B) Arrange an industrial visit to nearby petrochemical indusrty
(C) Mini project

10 SUGGESTED LEARNING RESOURCES

C. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Modern Petroleum Refining Processes	B. K.Bhaskar Rao	Oxford and IBH, 2007
2	Outlines of chemical Technology	M. Gopala Rao, Marshall Sittig	3rd Edition East-West press pvt. Ltd, Delhi
3	Shreve's Chemical Process Industries	Austin G.T.	McGraw Hill publication – New Delhi, 5th edition
4	A Text on Petrochemicals	B.K.Bhaskar Rao	2nd Edition, Khanna Publishers, Delhi, 1998
5	Petroleum Refinery Engineering	W.L.Nelson	McGraw Hill, Newyork, 1958

B. List of Major Equipment/Materials (With major specifications):

i. Penskey Martin Apparatus: Electrical heating with gas test jet and electric heater with energy regulator. Assembly is resting in air bath which is covered with dome shape metal top. The cup is fitted with insulated handle and locking arrangement. The round shaped heater with different temperature regulation system suitable for operation on 220 Volts AC mains.

ii. Cleaveland Flash and Fire Point Apparatus: The apparatus consists of a cup, heating plate, thermometer clip and test flame attachment with swivel joint for passing over liquids.

iii. Softening point and drop point Apparatus: Ring and Ball Apparatus with electric motorised stirrer and electric heater,concealed hot plate with temperature regulator.

iv. Drop Point Apparatus - hand operated stirrer, consists of brass sleeve and case with metal cup and a glass boiling tube with cork fitted to a bath (Beaker) is provided .

v. Penetrometer : A rack, pinion and pointer assembly, dial is graduated from 0-400 in on tenth millimeter sub division. Two samples containers made of Aluminium, round dial fitted on a Aluminium painted stand having adjustable penetration needle, holder sample container and transfer dish.

vi. Ram's bottom Apparatus: It consists of a solid metal bath having 6 walls to accommodate cocking bulbs with heating elements around the bath, the temperature may be controlled by a Pyrometer depending upon the type supplied, 6 cocking bulbs are supplied with apparatus.

vii. Conradson Apparatus: The Apparatus consists of Spun Sheet Iron Crucible 25cc capacity, sheet iron hood and sheet iron block on a stand with triangular wire bridge.

- Cloud and pour point Apparatus: It consists of a main cooling bath made of stainless steel sheet and stand unit with drain plug and cover with provision for fitting thermometer and a filling aperture for adding freezing mixture. A glass jar for containing oils, jacket, disc and gasket.
- Distillation Apparatus: The instrument consists of metal shield fitted with asbestos board to support distillation flask with height adjustable device. It has slide for vapour tube and lining having glass window for clear view of inside objects. The condenser bath is provided with Mild Steel black painted stand. Electrically operated on 220 volts AC mains.
- Red wood viscometer: Made of stainless steel bath big enough to accommodate 3 cups Redwood No.I and 2 cups of Redwood No.II. Oil cups fitted with Precision jets of Stainless Steel. Temperature is controlled by energy regulator.
- Saybolt Viscometer: Stainless Steel bath with oil cup which is centrally placed in a water bath. The bath has a lid which contains a Water Cooling Tube, Two handle with Two Stirrer Blades, Thermometer socket, Straight heater, Stirring is done by turntable arrangement.
- Engler Viscometer: It consists of Stainless steel water bath having oil cup with double walled lid. The water bath with stirring device mounted on stand. A thermometer clip to the water bath and the oil cup lid has a thermometer socket. The bath is fitted with 500 watts heater. It is supplied with wooden or ebonite valve to fit jet. It can operate on 220 Volts AC mains.
- Materials**:** Petrol, Diesel, Kerosene, Lube oil, Grease, Aniline

- **List of Software/Learning Websites**

www.personal.psu.edu/jun3/blogs/assignments/Oil%20Refinery.pdf
http://nptel.ac.in/courses/103103029/pdf/mod2.pdf
www.processengr.com/ppt_presentations/oil_refinery_processes.pdf
http://www.exxonmobil.com/Europe-English/Files/Simple_Guide_to_oil_refining.pdf
http://www.kau.edu.sa/Files/0001216/files/4354_Important%20Petrochemical%20Processes.p df

http://www.kau.edu.sa/Files/0053956/Subjects/Chapter%201%20petro.pdf
http://e-lib.dede.go.th/mm-data/Bib11162.pdf
http://chemicalsbestpractices.sap.com/Files/2_SAP_In_The_Chemical_Industry/2_2_Chemical_Subindustries/SAP_Petrochemicals_Overview.pdf
http://nptel.ac.in/courses/103103029/pdf/mod3.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. D. H. Joshi,** I/C H. O. D. in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. P. D. Chaudhary,** Lecturer in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. N. N. Hansalia,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. Mrs K. J. Sareriya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

COURSE TITLE: UTILITIES AND INSTRUMENTATION IN CHEMICAL PLANT
(COURSE CODE: 3350504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

5. RATIONALE

Diploma chemical engineer has to ensure smooth and proper operation of utilities and auxiliaries' plants such as steam, compressed air, instrumental air, inert gases, DM water and chilled water. These utilities are essential for manufacturing different chemical products. Use of measuring devices for the measurement of parameters like temperature, pressure, flow, level, viscosity, specific gravity, humidity are necessary for controlling chemical plant for producing materials of desired quality and to maintain plant safety. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

6. COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Operate different utility plants and various types of instruments**

5. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

xiv. Use various methods for water softening and purification
xv. Operate different types of steam generators
xvi. Operate compressors, blowers for handling air and inert gases
xvii. Use Refrigeration for Various applications
xviii. Measure temperature, pressure, flow, level and viscosity
xix. Operate various control valves and control systems

6. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Water as Basic Utility**	1a. Explain role of Utilities in Chemical Plant 1a.1 List various utilities in chemical plant & uses	1.1 List and use of various utilities in chemical plant
	1b. List sources of Water	1.2 Sources of water
	1c. Differentiate types of Water	Types of Water 1.3 Hard & Soft water 1.4 Boiler Feed water and demineralized water
	1d. Compare Softening processes of water	1.5 Methods of water softening processes • Lime soda process (Hot & Cold) • Zeolite process • Ion exchange process • Phosphate process
	1e. Explain the process of Purification of water from raw water with sketches.	1.6 Purification of water • Screening • Sedimentation • Coagulation • Filtration • Sterilization
Unit – II **Steam, Air & Inert Gases**	2a. Explain uses of utilities - Steam, Air & Inert Gases	Utilities : 2.1 Use of Steam, Air & Inert Gases as utilities
	2b. Define properties of steam	2.2 Properties of steam • Enthalpy • Wet steam • Saturated Steam • Superheated steam • Specific volume of steam
	2c. Label the different part of steam generator 2d. Classify steam generator 2e. Select steam generator 2f. compare steam generators 2g. List the Factors affecting selection of Boiler	2.3 Steam Generator : Classification , comparison , components 2.4 Factors affecting selection of Boiler
	2f. Describe construction and Working of Locomotive Fire tube boiler ,Lancashire boiler	2.6 Construction and working of (a) Locomotive Fire tube boiler (b) Lancashire boiler
	2g. Discuss utility air	2.7 Utility air • Compressed Air • Blower Air • Fan Air • Instrumental air
	2h. Describe the working principle, application ofAir compressors – (a) Reciprocating Air compressors (b) Multistage compressors (c) Rotary compressors	2.11 Types of Air compressors • Reciprocating Air compressors • Multistage compressors • Rotary compressors

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	2i. Describe properties of Inert gases	2.12 Inert gas - Nitrogen, Argon
Unit – III **Refrigeration**	3a. Explain the working principle of refrigeration	3.1 Concept of refrigeration
	3b. Distinguish methods of Refrigeration	3.2 Methods of Refrigeration • Ice Refrigeration • Evaporative Refrigeration • Vapor Refrigeration System
	3c. Describe COP and TOR of refrigeration	3.3 COP and TOR of refrigeration
	3d. Use primary and secondary Refrigerants	3.4 Types of Primary Refrigerants • Ammonia • Halo Carbons (Freon of Different type) • HFC (Hydro Fluorocarbon) 3.5 Types of secondary Refrigerants • Water • Brine 3.6 Selection of Refrigerants
Unit – IV **Basics of Instrumentation**	4a. Classify instruments in chemical plant	4.1 Importance of instrumentation in chemical plant 4.2 Classification of instruments
	4b. Describe Basic elements of instruments	4.3 Basic elements of instruments
	4c. Compare Static and Dynamic Characteristics of instruments	4.4 Static and Dynamic Characteristics of instruments
	4d. Differentiate First and second order system	4.5 First order system and second order system
Unit- V **Measuring Devices**	5a. Explain Temperature scale	5.1 Different Temperature scale
	5b. Compare thermometers 5b.1Explain Principle, Construction & Working of : Mercury in glass, Bi-metallic , pressure spring , resistance thermometers	5.2 Definition of thermometer 5.3 Principle, Construction & Working of : Mercury in glass thermometer, Bi-metallic thermometer, pressure spring thermometer, resistance thermometer,
	5c. Describe Principles of thermoelectricity and See-back effect, Peltier effect and Thomson effect	5.4 Principles of thermoelectricity 5.5 See-back effect, Peltier effect and Thomson effect
	5d. Describe principle, construction, working range, lead wires of thermocouple and Thermowells	5.6 Industrial thermocouple: their principle, construction, working range, lead wires 5.7 Thermowells in details
	5e. Explain principle, construction, and working of Radiation and optical Pyrometers	5.8 Radiation and optical Pyrometers
	5f. Differentiate pressure gauges	**1.** Pressure gauges - diaphragm, Bourdon tube gauge, Dead weight Gauge, Strain gauge
	5g. Describe principle,	5.10 Target meter, Vortex Shredding meter,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	construction, and working of Target meter, Vortex Shredding meter, Turbine meter	Turbine meter
	5h. Classify and explain level measuring devices	5.11 Classify: Liquid level measuring devices 5.12 Direct level measuring devices • Probe and tape • Sight glass • Floats 5.13 Indirect level measuring devices. • Air trap box method • Diaphragm box method • Bellow system • Differential pressure manometer
	5i. Compare viscosity measurement methods	5.14 Viscosity measurement by • Capillary tube method • Rotating cylinder method • Torsion viscometer
	5j. Explain principle, construction, and working	5.15 measurement of • Specific gravity by hydrometer • Humidity by hygrometer • pH by pH meter
Unit – VI **Control Valves, Control Loops & Control System**	6a. Explain Function of relays and interlocks	6.1 Function of relays and interlocks
	6b. Explain schematic control loops for -Temperature control -Pressure control - Flow control - Level control	6.2 Control loops • Temperature control • Pressure control • Flow control • Level control
	6c. Describe process control modes with sketches	6.6 Process control modes : P , P+I , P+I+D, ON -OFF
	6d. Explain uses of PLC and DCS System	6.7 PLC and DCS system

4 SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Water as Basic Utility	7	3	3	3	9
II	Steam, Air & Inert Gases	14	6	6	6	18
III	Refrigeration	7	3	3	3	9
IV	Basics of Instrumentation	4	2	2	1	5
V	Measuring Devices	18	7	8	7	22
VI	Control Valves, Control Loops & Control System	6	2	2	3	7
Total		**56**	**23**	**24**	**23**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

8. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	**Unit No.**	**Practical/Exercise** (Major outcomes in psychomotor domain)	**Apprx. Hrs. Required**
1	**I**	Operate water treatment in water treatment plant	**4**
2	**I**	Treat water using lime soda process	**4**
3	**II**	Generate steam in laboratory using baby boiler	**4**
4	**II**	Operate and test the working of air compressor	**4**
5	**III**	Demonstrate different refrigeration cycles	**4**
6	**V**	Measure Temperature by thermometer and thermocouple	**4**
7	**V**	Measure Temperature by Bi-metallic thermometer	**4**
8	**V**	Measure Pressure by mechanical pressure gauge	**4**
9	**V**	Measure gas flow rate	**4**
10	**V**	Measure level using direct method	**4**
11	**V**	Measure viscosity by capillary tube method	**4**
12	**V**	Measure specific gravity by Hydrometer	**4**
13	**V**	Measure humidity by Hair hygrometer	**4**
14	**V**	Measure pH by pH meter	**4**
15	**VI**	Prepare a chart of components of DCS system	**4**
16	**VI**	Demonstrate working of control valves and actuators using chart	**4**
	Total (perform any practical for total 56 hours so that most units are covered)		**64**

8. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1	Industrial instrumentation,	Donald P. Eckman.	JohnWilley and Sons, New York, 2004
2	Industrial Instrumentation & Control	S. K. Singh	3rd edition Tata-McGrawHil, 1987
3	Process Instrumentation and Control	A P Kulkarni	15th Edition, April 2011, Nirali Prakashan, Pune
4	Unit operation of chemical Engineering.	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7uu Edition
5	Plant utilities	D. B. Dhone	2nd Edition, 2012 Nirali Prakashan, Pune
6	Process System Analysis & Control	Donald R. Coughnour.	2nd edition, 1991, McGraw Hill Publication, Newyork

9. List of Major Equipment/Materials

i. Bi metallic thermometer – Metal Brass/Invar, Range – 40 ^{o} F 800 ^{o} F, 1 % span

ii. Thermo Couple – Thermocouple Wire: Pt/Rh or Fe/Constantan or Copper/Constantan, Range – Suitable to Material used, Lead Wire- Copper/Constantan, with suitable sheathing, with milivoltmeter, 1.5% accuracy

iii. Burdon Pressure Gauge – Arc Length – 270^{o}, Brass or Bronze or Copper or SS, Range 0-14 Kg/cm^{2}

iv. Gas Flow measurement Assembly

12. Level Measurement Assembly

13. Capillary tube viscometer – Oswald viscometer

14.Hair hygrometer

viii. Hydrometer

ix. Digital pH meter - Range 1-14 pH

C List of Software/Learning Websites

i. http://nptel.ac.in/courses/103103037/

ii. http://www.silbert.org/MSA_WT_Manual.pdf

iii. http://ppuchem.blogspot.in/2013/02/unit-1-notes.html

iv. http://www.tecmaservice.it/pdf/wika_%20brochure_chimica.pdf

v. http://www.npti.in/Download/Thermal/BoP/13%20Sulakshana%20Sule.pdf

vi. http://www.isu.edu/estec/ic-ed-modules/Module-10-Flow-Measurement.pdf

vii. http://www.betterbricks.com/sites/default/files/operations/om_of_boilers_final.pdf

viii. http://solve.nitk.ac.in/dmdocuments/electrical/DCS_write_up.pdf

ix. https://www.idc-online.com/technical_references/pdfs/instrumentation/ a. Industrial_Instrumentation%20-%20Flow.pdf

SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

Course/topic based presentation

Explore internet and visit websites of different chemical industries/supplier of plants and prepare reports on latest trends in utilities.

MCQ/Quiz

10. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Show animated and real videos/pictures of different plants
ii. Demonstrate different measuring instruments/sensors in class.
iii. Industrial visit of plant consisting water treatment plant and Boilers, Refrigeration and Control system
iv. Arrange lectures of persons from industry.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Ms. Yamini S. Patel,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Mr. M. R. Acharya,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia,** Lecture in Chemical Engineering ,Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

COURSE TITLE: CHEMICAL ENGINEERING THERMODYNAMICS (COURSE CODE: 3350505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

6. RATIONALE

Diploma Chemical engineer has to deal with the laws of thermodynamics which are applied to flow and non-flow processes in the plant to evaluate heat effects and energy transformation calculation accompanying physical and chemical changes, for calculating temperature change and to determine power generation efficiencies of engines and power plants. Understanding of basic concepts and application of thermodynamics are therefore necessary for chemical engineers. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

7. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Solve the problems related to heat and work requirements for physical and**

chemical changes.

6. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

xx. Distinguish systems, functions, properties and processes
xxi. Explain various laws of Thermodynamics
xxii. Implement the first law of thermodynamics for non-flow & flow process.
xxiii. Access the PVT behaviour of the fluids.
xxiv. Calculate the effects of heat changes during chemical reaction.
xxv. Apply the concepts of second law of thermodynamics.

7. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5 COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction and Basic Concept	1a. Describe scope of thermodynamics 1.1 Define System, functions, properties Process and surrounding 1b. Explain the System, functions, properties , Process and surrounding with examples of chemical engineering field 1c. Differentiate systems, functions, properties and processes 1d. Describe Extensive and intensive properties 1e. Explain importance of Force, Pressure, Work and Energy physical quantities, phase rule and zeroth law of thermodynamics 1f. Solve simple problems on -Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics	1.1 Scope and limitations of thermodynamics 1.2 System, functions, properties Process and surrounding 1.2.1 System-Homogeneous and heterogeneous, Closed and open, State of System 1.2.2 Properties -Extensive and intensive 1.2.3 Function -State and Path function 1.2.4 Process -Reversible and irreversible process 1.3 Force, Pressure, Work and Energy 1.4 Steady state, Equilibrium state and Phase rule 1.5 Temperature and zeroth law of thermodynamics 1.6 Ideal gas temperature scale 1.7 Simple examples (numerical)on Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics
Unit – II First Law of Thermodynamics	2a. Explain first law and energy - Internal Energy, Enthalpy and Heat capacity concepts with examples of chemical engineering 2b. Apply first law for non-flow & flow process of chemical	2.1 First law of thermodynamics 2.2 Internal Energy, Enthalpy and Heat capacity 2.3 First law for non-flow processes and flow processes of chemical engineering

	engineering 2c. Solve simple problems on first law and energy - Internal Energy, Enthalpy and Heat capacity	2.4 Simple numerical on first law and energy - Internal Energy, Enthalpy and Heat capacity
Unit – III PVT Behavior	3a. Explain PVT behaviour of pure fluids 3b. Distinguish Ideal gas Processes 3c. Compare equations of state for real gases 3d. Solve simple problems on Ideal gas Processes, Equation of state for real gases,	3.1 PVT behavior of pure fluids 3.2 Ideal gas and equation of state 3.3 Ideal gas Process : 3.3.1 Constant Volume process 3.3.2 Constant Pressure process 3.3.3 Constant Temperature process 3.3.4 Adiabatic Process 3.3.5 Polytropic Process 3.4 Equation of state for real gases 3.4.1 Vander Waals Equation 3.4.2 Virial Equation 3.4.3 Compressibility charts 3.5 Simple examples(numerical)
Unit	**Major Learning Outcomes** (in cognitive domain)	**Topics and Sub-topics**
Unit – IV Heat Effects	4a. Explain the heat effects of chemical reactions 4b. Apply Hess's law of constant heat summation 4c. Calculate heat of reaction and temperature of reaction 4d. Solve simple problems on heat Effects in chemical reactions	4.1 Heat effects accompanying chemical reactions: 4.1.1 The standard heat of reaction 4.1.2 The standard heat of combustion 4.1.3 The standard heat of formation 4.2 Hess's Law of constant heat summation 4.3 Effects of temperature on heat of reaction 4.4 Temperature of reaction 4.5 Simple numerical
Unit – V Second Law of Thermodynamics	5a. Discuss limitation of first law 5b. Compare different statements of Second law 5c. Describe the concepts of Heat reservoir, Heat engine and Heat pump 5d. Explain entropy 5e.Explain carnot cycle and thermodynamic temperature scale 5f. Calculate entropy changes 5g. Explain the concept of entropy and irreversibility 5h. Solve simple problems on Second law	5.1 Limitations of first law 5.2 Statements of Second law 5.3 Heat reservoir, Heat engine and Heat pump 5.4 Concept of Entropy 5.5 Carnot cycle and thermodynamic temperature scale 5.6 Calculation of Entropy change during 5.6.1 Phase change 5.6.2 Ideal gas processes 5.6.3 Adiabatic mixing 5.6.4 Isothermal mixing 5.6.5 Chemical reaction 5.7 Clausius Inequality 5.8 Mathematical statement of Second law 5.9 Entropy and Irreversibility 5.10 Simple numerical

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Mark
I	Introduction and Basic Concept	07	3	4	5	12
II	First Law of Thermodynamics	06	3	3	4	10
III	PVT behavior	09	5	5	5	15
IV	Heat Effects	07	4	4	4	12
V	Second Law of Thermodynamics	13	7	7	7	21
Total		**42**	**22**	**23**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

----------NIL----------

9. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

Course/topic based presentation
MCQ/Quiz

B. SPECIAL INSTRCTIONAL STRATEGY (IF ANY)

Give as many simple numerical problems to students as possible in class itself and help them to solve if they get stuck.

10. SUGGESTED LEARNING RESOURCES A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Chemical Engineering Thermodynamics	K. V. Narayanan	PHI publishers
2	Introduction to Chemical Engineering Thermodynamics	J. M. Smith H.C. Vanness M. M. Abott	Tata McGraw Hill
3	Thermodynamics	C.P.Arora	Tata McGraw Hill
4	Chemical Engineering Thermodynamics	Y. V. C. Rao	Universities Press

5	Chemical Process Principles Vol.2	A.Hougen K.M.Watson R.A.Ragatz	Asia Publications
6	Textbook of Engineering Thermodynamics	R. K. Rajput	Laxmi Publication
7	Chemical Engineering Thermodynamics	R. B . Varia	Atul Prakashan
8	Applied Thermodynamics	P. B. Joshi	Nirali Prakashan

B. List of Major Equipment/Materials

----------**Nil** ----------Theoretical Approach)

C. List of Software/Learning Websites

i. www.unitoperation.com
ii. www.nptel.com

2 COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

12. **Prof. Manish R. Nasit,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli - Ahwa.
13. **Prof. Mukesh B. Dhangar,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli-Ahwa.
14. **Prof. R. P. Hadiya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences